

Application No. 10/562,454

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REMARKS

Reexamination and reconsideration of this application is respectfully requested in light of the foregoing amendments and the following remarks.

Claims 1 and 4-10 are pending in this application. Claims 2 and 3 have been canceled without prejudice or disclaimer. No new claims have been added. Claim 1 has been amended to incorporate the limitations of canceled dependent claims 2 and 3. Therefore, the amendment should not raise an issue of new matter. In addition, dependent claims 4-10 have been amend to be each dependent on claim 1, thereby addressing the Examiner's objection to the claims as being improper multiple dependent claims.

Applicant notes the Examiner's consideration of the information cited in the Information Disclosure Statements filed December 27, 2005, May 10, 2007 and October 5, 2007, as acknowledged in the Office Action Summary. Applicant further notes the Examiner's acknowledgment of Applicant's claim for foreign priority under 35 U.S.C. § 119 and receipt of the certified priority document.

Objection to Claims

Claims 4-10 have been objected to under 37 C.F.R. § 1.75(c) as being improper because they are multiple dependent claims dependent on multiple dependent claims. The claims have been amended to be each dependent on claim 1. Accordingly, by these amendments, the objection should be overcome. It is therefore requested that the objection be reconsidered and withdrawn. It is further requested that in view of the amendments, claims 4-10 be treated and examined on the merits.

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Rejection Under 102(e) Based On Yamamoto

Claims 1-3 stand rejected under 35 U.S.C. § 102(e) as being anticipated by Yamamoto et al. (U.S. Patent No. 6,824,601). Claims 2 and 3 have been canceled, thereby rendering the rejection of these claims moot. The limitations of claims 2 and 3 have been incorporated into claim 1.

The present invention as set forth in claim 1 is directed to coating the surface of a cubic boron nitride sintered compact substrate (CBN) with a coating film layer of a specific TiAlN composition, wherein the coating does not peel off during high precision cutting. See Applicant's disclosure at paragraph [0005] and [0006].

The coating film layer comprises $Ti_{1-x}Al_xN$, where $0.3 \leq x \leq 0.6$. The range of x is critical. See paragraph [0010] of the specification. If x exceeds 0.6, a moderation effect of compressive stress caused by the difference in thermal expansion coefficient with respect to the CBN substrate is reduced so that the high compressive stress in the film remains, causing the coating film layer to peel off easily during a cutting operation. If x is less than 0.3, the hardness of the coating film layer is too low causing reduced wear-resistance. The range for x is a balance between wear resistance and peeling-off resistance.

The coating film has a critical thickness of from 0.1 μm to 1 μm . As evidenced by a comparison Sample Nos. 1-4, 9-11, 21-23 to Sample Nos. 5-8, 12-14 and 24 in Tables 1 and 2 of the specification, damage to the coating film layer is significantly reduced when the coating composition is $Ti_{1-x}Al_xN$, where $0.3 \leq x \leq 0.6$ and the coating film layer thickness is from 0.1 μm to less than 1 μm .

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Further, the coating film layer has a crystal structure having (111) and (200) planes, wherein the diffraction strength of the (111) and (200) planes have the following relationship:

$$0 \leq I(200)/I(111) \leq 3.$$

This ratio is critical. See paragraph [0009] of the specification. If the value exceeds 3, the compressive stress is reduced, the crystal grain becomes coarse resulting in reduced wear resistance and fracture resistance which are detrimental to the cutting operation.

The Examiner finds that claim 1 is anticipated by Yamamoto et al. Applicant respectfully traverses this rejection because the coating film layer disclosed in the reference necessarily includes Cr, which is not present in the claimed subject matter. Assuming that integer b is greater than 0.06 and c = d = 0 and e = 1, the coating composition of Yamamoto et al. becomes $Ti_{1-a}Al_aCr_bN$. This composition necessarily includes Cr, which is not present in the film composition as claimed. While Table 1 in Yamamoto et al. at col. 17 discloses coating film comprising TiAlN where, $0.56 \leq Al \leq 0.75$, the patentees state that the films do not have the improved film hardness in contrast to the compositions containing Cr (col., 17, lines 31-36). Therefore, the reference teaches away from leaving Cr out of the coating composition. Furthermore, the coatings were applied to a cemented carbide, and not to CBN as required by claim 1. Still further, Yamamoto's coating thickness is 4 μm , which is outside the range set forth in claim 1.

While integer "a" in Yamamoto's $TiAlCrN$ formula is equal to or greater than 0.5, but less than or equal to 0.8 and overlaps the range for "x" as set forth in claim 1, Yamamoto et al. do not recognize the criticality of the combined thickness and amount of Al in the coating film

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layer composition to avoid peeling. Yamamoto et al. disclose coating thicknesses of 3 μm or more. While Example 5 (Table 5) and Example 15 (Table 17) show coating thicknesses less than 1 μm , the coatings applied are TiAlCrN and TiAlCr, respectively, which are not within the scope of TiAlN as set forth in claim 1. Also, the coating film layers in Examples 5 and 15 are applied to a cemented carbide, and not to a CBN as required by claim 1. For all of these reasons, claim 1 would not be anticipated by Examples 5 and 15 of Yamamoto et al.

Example 7 in Yamamoto et al. discloses a $\text{Ti}_{0.54}\text{Al}_{0.46}\text{N}$ coating film layer applied to a cemented carbide, and not applied to a CBN as required by claim 1. In addition, the coating thickness is 3.5 μm thick, which is outside the thickness range disclosed in claim 1. For these reasons, claim 1 would not be anticipated by Example 7 of Yamamoto et al.

In Example 9 of Yamamoto et al., while the Example shows a TiAlN composition within the scope of the invention, the total thickness of the coating is 3 μm , which is not within the scope of claim 1. The term "film thickness" of the coating film is defined in Applicant's specification at paragraph [0011] as meaning "total film thicknesses of various layers such as the intermediate layer, the wear-resistant layer and the outermost layer." Since Yamamoto's total thickness is 3 μm and since the coating is applied to a cemented carbide, and not a CBN substrate, claim 1 would not be anticipated by Example 9 of Yamamoto et al.

Examples 12 and 14 of Yamamoto et al. disclose a TiAlN coating composition having a thickness of 0.5 μm . See Tables 14 and 16, respectively. This thickness is within the scope of claim 1. However, neither Example discloses coating a CBN substrate as required by claim 1. Accordingly, claim 1 would not be anticipated by Examples 12 and 14 of Yamamoto et al.

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Yamamoto et al. do not disclose or suggest that a coating film layer comprising TiAlN as set forth in claim 1 is capable of exhibiting superior wear resistance and fracture resistance. In fact, the reference appears to teach away from using such compositions. See col. 21, lines 17-19; col. 22, lines 63-67; and col. 24, lines 21-27; where TiAlN and TiAlCrN coatings are compared.

Finally, Yamamoto et al. discloses diffraction strength ratio [I(200)/I(111)] of less than 3. However, the ratio is related to a composition containing Cr, that is TiAlCrN, and not to a TiAlN composition. See for example Tables 10 and 12 as well as Examples 10 and 11, respectively. Therefore, the diffraction strength ratio disclosed in Yamamoto et al. is not directed to a TiAlN coating.

For all of the foregoing reasons, the rejection does not establish a *prima facie* case of anticipation of claim 1 over the disclosure of Yamamoto et al.

Rejections Under 102(e) Based On Ota, Vetter or Kukino I

Claims 1-3 stand rejected under 35 U.S.C. § 102(e) as being anticipated by Ota et al. (U.S. Patent No. 6,737,178) or Vetter et al. (U.S. Patent No. 6,730,392) or Kukino et al. (U.S. Patent No. 6,623,850 [hereinafter Kukino I]). Claims 2 and 3 have been canceled, thereby rendering the rejection of these claims moot. According to the Examiner, the references disclose the claimed (Ti,Al)(C,O,N) within the claimed thickness range. The composition of the coating film is expressed in claim 1 as $(Ti_{1-x}Al_x)N$, wherein $0.3 \leq x \leq 0.6$. Therefore, carbon and oxygen are not present in the claimed composition. Applicant respectfully traverses this rejection on other grounds as set forth below.

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As for Kukino I, in the background of the invention, Kukino I refers to a Japanese application disclosing a TiAlN coated CBN substrate (col. 2, lines 34-44). However, there is no disclosure regarding the thickness of the coating, the specific composition of the TiAlN coating, or the diffraction strength ratio required in claim 1. The invention disclosed in Kukino I is directed to coating CBN with a hard coat layer such as TiAlN, the coating thickness being at least 0.5 μm to at most 10 μm . While the reference discloses that the starting composition for vaporizing the coating is “compound of (Ti 0.5, Al 0.5)” (see col. 9, lines 24-26 and col. 10, lines 6-14), the reference does not specify the composition the coating composition as formed. Even assuming that the coating formed comprises $\text{Ti}_{0.5}\text{Al}_{0.5}\text{N}$, Kukino I does not deposit the coating directly on a CBN substrate, but on an intermediate layer such as Cr. See Table 1. Claim 1 requires the coating to be formed on the surface of the substrate. In addition to the above, while Kukino I discloses coating thicknesses from at least 0.5 μm to at most 10 μm , the reference does not recognize the criticality of the thickness and the amount of Al in the coating composition as well as the required diffraction strength ratio as set forth in claim 1. Almost all of the thicknesses for the coated TiAlN layer 3.0 μm or greater. See Tables 1, 3 and 4. Applicant does recognize that Table 1 includes Sample Nos. 17 and 18 which have thicknesses less than 1 μm . However, there is no teaching or disclosure that TiAlN composition in these samples would have the composition and diffraction strength ratio as set forth in claim 1 and would not peel-off the CBN substrate. For all of the foregoing reasons, claim 1 is not anticipated by Kukino I.

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As for Ota et al., this reference teaches coating a CBN substrate with TiAlN coating having a thickness between 0.3 μm and 10 μm . However, the reference fails to disclose the TiAlN coating as $\text{Ti}_{1-x}\text{Al}_x\text{N}$, where $0.3 \leq x \leq 0.6$. See Tables 1-5 and the Examples. The reference does disclose TiAlN in Table 5 (Examples 5-7 and 5-8), but the thickness of the coatings are 2 μm , which is not within the scope of the thickness range set forth in claim 1. Ota et al. do not disclose or teach the critically of the combination of thickness and Al content in the coating. Further, the reference is silent to a diffraction strength ratio [$I(200)/I(111)$] of the coating film layer. For all of the foregoing reasons, claim 1 is not anticipated by Ota et al.

Vetter et al. disclose hard layer coating comprising $\text{Ti}_{1-x}\text{Al}_x\text{N}$, where $0.5 \leq x \leq 0.5$ on tungsten carbide (col. 3, lines 60-67). The coating is not applied to CBN as required by claim 1. Further, the coating thicknesses disclosed by Vetter are greater than 1 μm , and therefore not within the scope of claim 1. See col. 3, lines 27-31. As for the diffraction strength ratio, Vetter does not disclose the ratio with respect to specific TiAlN coatings. Vetter et al. does not relate the TiAlN composition, coating thickness and the diffraction strength ratio of the coating formed to solving the peeling problem. For all of the foregoing reasons, claim 1 is not anticipated by Vetter et al.

Rejections under 102(b) Based On Uniaxis or Toshiba

Claims 1-3 stand rejected under 35 U.S.C. § 102(b) as being anticipated by Uniaxis (EP 1021584) or Toshiba Tungaloy Co. Ltd. (JP 2002-003284 [hereinafter Toshiba]). Claims 2 and 3 have been canceled, thereby rendering the rejection of these claims moot.

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According to the Examiner, Uniaxis and Toshiba disclose the claimed $(\text{Ti},\text{Al})(\text{C},\text{O},\text{N})$ within the claimed thickness range. The composition of the coating film is expressed in claim 1 as $\text{Ti}_{1-x}\text{Al}_x\text{N}$, wherein $0.3 \leq x \leq 0.6$. Therefore, carbon and oxygen are not present in the claimed composition. Applicant respectfully traverses this rejection on other grounds as set forth below.

Uniaxis does not disclose coating the surface of CBN with a hard coating of TiAlN. The reference discloses coating HSS (steel) or a cemented carbide with an intermediate layer and then a $\text{Ti}_{1-x}\text{Al}_x\text{N}$ layer, where $0.4 \leq x \leq 0.6$. The thickness of the TiAlN layer is about 4 μm . See Table 2. The reference does not disclose a coating thickness as being less than 1 μm as required by claim 1. As for the diffraction strength ratio of the coating, Uniaxis defines a diffraction strength ratio as being at least 1.5. However, the reference does not disclose a critical upper limit for the ratio. Moreover, the reference teaches away from a ratio value less than 3. In Table 5, a substrate coated with $\text{Ti}_{0.6}\text{Al}_{0.4}\text{N}$ layer exhibited "peeling off." Uniaxis does not show or suggest that if the $I(200)/I(111)$ ratio exceeds 3 for coating layer of $\text{Ti}_{1-x}\text{Al}_x\text{N}$, where $0.4 \leq x \leq 0.6$, the compressive stress is reduced, the crystal grain becomes coarse resulting in reduced wear resistance and fracture resistance which are detrimental to the cutting operation. For all of the foregoing reasons, claim 1 is not anticipated by Uniaxis.

Toshiba discloses applying a hard TiAlN coating on a CBN substrate. However, the reference fails to disclose a specification composition of TiAlN as set forth in claim 1. Further, the thickness of the coating is from 1 to 20 μm , which is outside the claimed range of from 0.1 μm to less than 1 μm . See page 7 of the English translation. Further, Toshiba defines a diffraction strength ratio of the hard coating to be 8.5, which is not within the scope of claim 1.

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See Tables 4 and 12. In Table 5, Toshiba discloses articles satisfying the I(200)/I(111) ratio of less than 1. See Table 5, articles Nos. 4 and 5. However, the hard coating is not TiAlN, but TiNO and TiCN, respectively. For all of the foregoing reasons, claim 1 is not anticipated by Toshiba.

Rejections under 102(b) Based On Sumitomo, AST, Oles, Prizzi, Kukino II, Kukino III, Goto, Luthier, Gavrilov or Gates, Jr.

Claims 1 and 3 stand rejected under 35 U.S.C. § 102(b) as being anticipated by Sumitomo (JP 2001-293602 or Agency of Sci & Technology (JP 2000-308906 [hereinafter the AST]) or Oles et al. (U.S. Patent No. 6,599,062) or Prizzi et al. (U.S. Patent No. 5,879,823) or Kukino et al. (U.S. Patent No. 5,882,777 [hereinafter Kukino II] or U.S. Patent No. 5,853,873 [hereinafter Kukino III]) or Goto et al. (U.S. Patent No. 5,712,030) or Luthier et al. (U.S. Patent No. 5,030,522) or Gavrilov et al. (U.S. Patent No. 4,753,854) or Gates, Jr. (U.S. Patent No. 4,714,660). Claim 3 has been canceled thereby rendering the rejection of this claim moot.

The Examiner finds that each of the references disclose the claimed $(\text{Ti},\text{Al})(\text{C},\text{O},\text{N})$ within the claimed thickness range. Claim 1 recites that the claimed coating film $\text{Ti}_{1-x}\text{Al}_x\text{N}$, where $0.3 \leq x \leq 0.6$. Therefore, carbon and oxygen are not present in the claimed composition. For other reasons set forth below, Applicant respectfully traverses this rejection.

The Luthier et al., Gavrilove et al. and Gates, Jr. references do not disclose CBN substrates, let alone substrates coated with a TiAlN hard coating. Luthier et al. merely discloses a black-colored coating for decorating a watch housing or a watch wristlet, as described in col. 1, lines 7-10. Luthier et al. is completely silent to possibility of applying their invention to cutting tools. Further, the substrate disclosed by Luthier et al. is stainless steel, and not a CBN as

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required by claim 1. In addition, the coating disclosed by Lutheir et al. is TiAlON, and not TiAlN as required by claim 1. Gavrilov et al. discloses using high-speed cast steel, high-speed steel powder, or a non-metallic refractory composition to a substrate as described in col. 3, lines 46-51. However, Gavrilov et al. do disclose coating boron nitride, but not specifically coating a CBN substrate. Further, the wear-resistant coating of Gavrilov et al. is characterized in comprising TiAlMoVN, TiAlMoVCO, TiAlMoVC, TiAlMoVZrN or TiAlMoVZrB, and not TiAlN as required by claim 1. See Examples 1 to 10 of Gravilov et al. In addition, the thicknesses of Gavrilov's coatings are outside the scope of claim 1. Gavrilov et al. do not disclose a range of thicknesses, but the Examples disclose coating thicknesses of 6 μm . Gates, Jr. coats cemented carbides, and not CBN as required by claim 1. Further, Gates, Jr. applies TiAlOCN coatings, and not a TiAlN as required by claim 1. See Examples 6 and 7, and Tables I and II of Gates, Jr. Still further, the thicknesses of Gates' coatings range from 7.0 μm to 9.5 μm . This range of thicknesses is substantially outside the range of claim 1. For all of the foregoing reasons, claim 1 would not be anticipated by Luthier et al, Gavrilove et al or Gates, Jr.

The Sumitomo reference is an English abstract attached to a Japanese patent application and it discloses coating a CBN body with a nitride having Al and a metal selected from Group 4a, 5a or 6a of the Periodic Table. Tables 1 and 2 in the reference disclose a TiAlN coating having thicknesses from ranging from 2.5 μm to 3.0 μm . The reference does not disclose a coating film layer of $\text{Ti}_{1-x}\text{Al}_x\text{N}$, where $0.3 \leq x \leq 0.6$ as required by claim 1, let alone a thickness for the coating layer less than 1 μm as required by claim 1. In addition, the reference is silent on the diffraction strength ratio being equal to or less than 3. Further, the wear-resistance coating of

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Sumitomo is characterized as having been prepared using ultrafine compounds dispersed in the coating. If a cutting tool with the coating of Sumitomo performs high precision cutting or grooving of quenched steel, a chip of the tool will wear down uniformly since the coating does not have uniform hardness due to dispersion of ultrafine compounds in the coating. Consequently, a surface roughness of a work piece being grooved becomes worse and the high precision cutting or grooving may not finish properly. For all of the foregoing reasons, claim 1 would not be anticipated by the Sumitomo reference.

The AST reference is an English abstract attached to a Japanese patent application and it discloses coating a cemented carbide alloy cutting tool with a coating layer of $Ti_xAl_{1-x-y}(SiC)_yN$, where $0.3 \leq x \leq 0.7$ and $0.02 \leq y \leq 0.2$. This coating is not TiAlN as required by claim 1. The AST coating must necessarily include SiC as a component in the coating, which is not recited in claim 1. However, the table in the Japanese patent application discloses a coating layer of $Ta_{0.5}Al_{0.5}N$ having a thickness of $3.5 \mu m$. This thickness, however, is outside the thickness range set forth in claim 1. In addition, the abstract describes the substrate as being made of tungsten carbide containing cobalt. The abstract does not disclose or suggest a CBN substrate. Accordingly, the AST reference fails to disclose the substrate material set forth in claim 1, namely, CBN. Also, the AST reference is silent as to diffraction strength ratio required by claim 1. For all of the foregoing reasons, claim 1 would not be anticipated by the AST reference.

The Oles et al. patent discloses a cutting tool comprising CBN coated with of a hard refractory coating. The thickness of the coating is disclosed to be in the range from $2 \mu m$ to $5 \mu m$ (col. 2, line 25 and col. 3, line 54). The thickness is outside the range set forth in claim 1.

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Further, the reference fails to disclose a coating layer of $Ti_{1-x}Al_xN$, where $0.3 \leq x \leq 0.6$, or the diffraction strength ratio required by claim 1. For all of the foregoing reasons, claim 1 would not be anticipated by Oles et al.

Prizzi et al. discloses coating CBN substrate with a layer of $Ti_aAl_{1-a}N$, where $0 < a < 1$ (col. 7, lines 6-12 and 37-40). However, the coating thickness is between 1 μm and 4 μm , which is outside the range set forth in claim 1. Further, the reference fails to recognize the combined properties of the coating as having "a" between 0.3 and 0.6 and the thickness of the coating being less than 1 μm to achieve the benefit of preventing peeling of the TiAlN layer. Still further, the reference is silent as to the diffraction strength ratio. For all of the foregoing reasons, claim 1 would not be anticipated by Prizzi et al.

Kukino II is directed to coating a CBN substrate with a film consisting of super thin films (a) and (b) which are deposited alternatively as shown in Fig. 1 of the patent. The reference, however, does not disclose the coating layer to be $Ti_{1-x}Al_xN$, where $0.3 \leq x \leq 0.6$. Therefore, the reference fails to recognize the formula or criticality of the amount of Al in the formula. The reference discloses a generic TiAlN formula set forth as Sample Nos. 3-9 to 3-16 in Table 3 of the reference. However, the thicknesses of the coatings ranges from 1 μm to 50 μm , none of which are within the claimed range set forth in claim 1. In addition, the reference is silent as to the diffraction strength ratio that is required in claim 1. For all of the foregoing reasons, claim 1 would not be anticipated by Kukino II.

Kukino III discloses a substrate of CBN coated with a layer of $Ti_{1-x}Al_xN$, where $0.3 \leq x \leq 0.5$ (col. 3, lines 16-25). The thickness of the layer can range from 0.5 μm to 15 μm . While the

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broad disclosures are within the scope of claim 1, the examples set forth in Example 1 (Sample Nos. 1-1 to 1-5 and 1-24 to 1-28 in Table 1) and Example 2 recited ranges far greater than 1 μm . Moreover, Sample Nos. 1-24 to 1-28 do not apply the coating on the surface of the CBN. The coating is applied to an intermediate layer of TiN. As for Sample Nos. 1-1, 1-2, and 1-5, the value of x in the TiAlN formula is outside the claimed range. While Sample Nos. 1-3 and 1-4 do recite an x value within the claimed range, the thickness of the coating is not within the claimed thickness range. Further, the reference fails to recognize the combined properties of the coating as having “ x ” between 0.3 and 0.6 and the thickness of the coating being less than 1 μm to achieve the benefit of preventing peeling of the TiAlN layer. Still further, the reference is silent as to the diffraction strength ratio that is also required by claim 1. For all of the foregoing reasons, claim 1 would not be anticipated by Kukino III.

Goto et al. discloses in a cutting tool comprising a CBN coated with a layer of $\text{Ti}_{0.5}\text{Al}_{0.5}\text{N}$. See Fig. 12A; Example 5 (Table 4, Sample No. 4-8 and Table 6, Sample Nos. 4-20 and 4-25), Example 6 (Table 7, Sample No. 5-3). However, the thickness of the coatings are 5 μm , 4.5 μm , 5 μm and 4 μm , respectively. These thicknesses are substantially outside the scope of the thickness range recited in claim 1. The reference fails to recognize the combined properties of the coating as having “ x ” between 0.3 and 0.6 and the thickness of the coating being less than 1 μm to achieve the benefit of preventing peeling of the TiAlN layer. Also, the reference is silent as to the diffraction strength ratio required by claim 1. For all of the foregoing reasons, claim 1 would not be anticipated by Goto et al.

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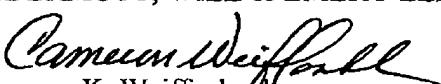
Conclusion

For the foregoing reasons, it is submitted that the claim 1 is patentable over the teachings of the prior art relied upon by the Examiner. In view of the amendments to claims 4-10, it is respectfully requested that the claims be examined on the merits. Accordingly, favorable reconsideration of the claims is requested in light of the preceding amendments and remarks.

If there are any outstanding issues that might be resolved by an interview or an Examiner's amendment, the Examiner is requested to call Applicant's attorney at the telephone number shown below.

To the extent necessary, a petition for an extension of time under 37 C.F.R. § 1.136 is hereby made. Please charge any shortage in fees due under 37 C.F.R. § 1.17 and due in connection with the filing of this paper, including extension of time fees, to Deposit Account 500417 and please credit any excess fees to such deposit account.

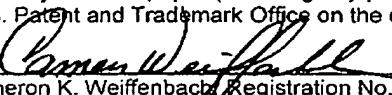
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